The documentation and process conversion measures necessary to comply with this revision shall be completed by 3 October 1998

METRIC

MIL-PRF-19500/594A
3 July 1998
SUPERSEDING
MIL-S-19500/594
29 October 1993

PERFORMANCE SPECIFICATION SHEET

# SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, FAST RECOVERY, LOW LEAKAGE, TYPES 1N6664 THRU 1N6666, AND 1N6664R THROUGH 1N6666R JAN, JANTX, JANTXV, AND JANS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers the performance requirements for a silicon, fast recovery power rectifier diodes. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO-257AA).

1.3 Maximum ratings (per leg).

| Types | $V_R$ and $V_{RWM}$ | $I_O$ 1/ $T_C$ = +100°C | $I_{FSM}$ $T_C$ = +100°C $t_p$ = 8.3 ms | $t_{rr}$ | $T_{STG}$ and $T_{OP}$ |
|---|---|---|---|---|---|
| | V dc | A dc | A dc | ns | |
| 1N6664, 1N6664R | 100 | 10 | 50 | 35 | +100°C |
| 1N6665, 1N6665R | 150 | 10 | 50 | 35 | to |
| 1N6666, 1N6666R | 200 | 10 | 50 | 35 | -65°C |

1/ Derate linearly, 100 mA/°C from +100°C to +200°C.
Storage temperature: $T_{STG}$ = -65°C to +200°C.
Operating temperature: $T_J$ = -65°C to +200°C.
Barometric pressure reduced (altitude operation): 8 mmHg.
$R_{\theta JC}$ = 2.5°C/W maximum.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad Street, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

DEPARTMENT OF DEFENSE

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.3 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 (TO 257) herein.

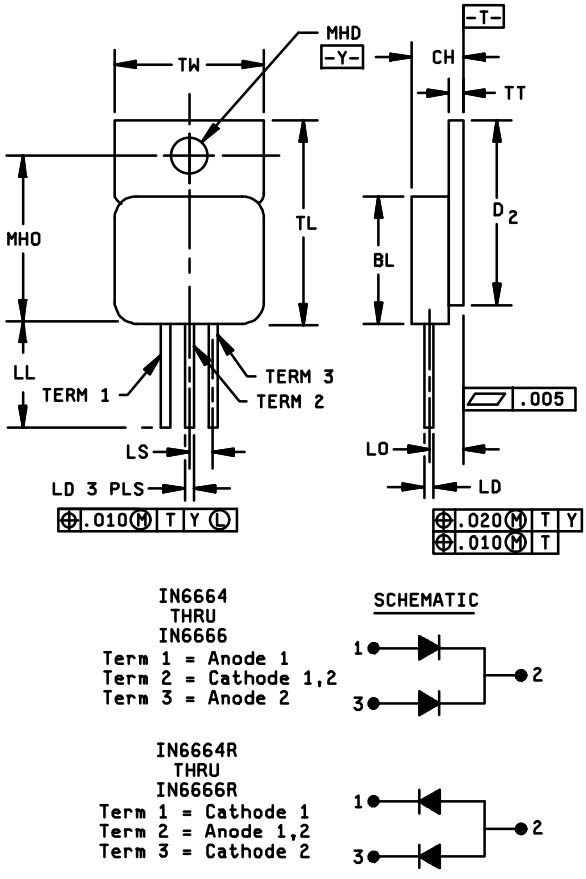
3.3.1 Lead material and finish. Lead material shall be 52 alloy, copper core. Lead finish shall be solderable as defined in MIL-STD-750, MIL-PRF-19500, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3 herein.

| Ltr | Dimensions | | | |
|---|---|---|---|---|
| | Millimeters | | Inches | |
| | Min | Max | Min | Max |
| BL | 10.41 | 10.92 | .410 | .430 |
| CH | 4.83 | 5.08 | .190 | .200 |
| LD | 0.64 | 0.89 | .025 | .035 |
| LL | 12.82 | 15.11 | .505 | .595 |
| LO | 3.05 BSC | | .120 BSC | |
| LS | 2.54 BSC | | .100 BSC | |
| MHD | 3.56 | 3.81 | .140 | .150 |
| MHO | 13.39 | 13.64 | .527 | .537 |
| TL | 16.38 | 16.89 | .6450 | .665 |
| TT | 0.89 | 1.14 | .035 | .045 |
| TW | 10.41 | 10.67 | .410 | .420 |
| Term 1 | See schematic | | | |
| Term 2 | See schematic | | | |
| Term 3 | See schematic | | | |




NOTES:
1. Dimensions are in millimeters.
2. Inch equivalents are given for general information only.
3. Glass meniscus included in dimension TL and BL.

FIGURE 1. Dimensions and configuration (T0-257AA).

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3)

c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

4.2.1 Construction verification. Cross sectional photos from three devices shall be submitted in the qualification report.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with MIL-PRF-19500 (Appendix E, table IV), and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

| Screen (see appendix E, table IV of MIL-PRF-19500) | Measurement | |
|---|---|---|
| | JANS level | JANTX and JANTXV levels |
| 3c 1/ | Thermal impedance (see 4.3.2) | Thermal impedance (see 4.3.2) |
| 4 | $Y_1$ at 10,000 G | Not applicable |
| 9 | Not applicable | Not applicable |
| 11 | Subgroup 2 of table I herein;<br>$V_{F2}$ and $I_{R1}$ | Subgroup 2 of table I herein;<br>$V_{F2}$ and $I_{R1}$ |
| 12 | See 4.3.1, MIL-STD-750, method 1038, test condition A, t = 96 hours | See 4.3.1, MIL-STD-750, method 1038, test condition A, t = 48 hours |
| 13 | Subgroups 2 and 3 of table I herein;<br>$\Delta V_{F2} = \pm 0.05$ V (pk);<br>$\Delta I_{R1}$ = 150 nA dc or 100 percent of the initial value, whichever is greater. | Subgroup 2 of table I herein;<br>$\Delta V_{F2} = \pm 0.05$ V (pk);<br>$\Delta I_{R1}$ = 150 nA dc or 100 percent of the initial value, whichever is greater. |

1/ Thermal impedance shall be performed any time after sealing provided. Temperature cycling is performed in accordance with MIL-PRF-19500, screen 3 prior to this thermal impedance.

4.3.1 Burn-in conditions. Burn-in conditions are as follows: $T_A$ = +150°C; $V_R$ = 0.8 to 0.85 rated $V_R$ dc (see 1.3).

4.3.2 Thermal impedance $Z_{\theta JX}$ measurements for screening. The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3101. The maximum limit (not to exceed the group A, subgroup 2 limit) for $Z_{\theta JX}$ in screening (table II of MIL-PRF-19500) shall be derived by each vendor by means of statistical process control. When the process has exhibited control and capability, the capability data shall be used to establish the fixed screening limit. In addition to screening, once a fixed limit has been established, monitor all future sealing lots using a random five piece sample from each lot to be plotted on the applicable X, R chart. If a lot exhibits an out of control condition, the entire lot shall be removed from the line and held for Engineering evaluation and disposition.

4.3.2.1 Thermal impedance ($Z_{\theta JX}$ measurements) for initial qualification or requalification. The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3101 (read and record date $Z_{\theta JX}$). $Z_{\theta JX}$ shall be supplied on one lot (500 pieces minimum and a thermal response curve shall be submitted. Twenty two of these samples shall be serialized and provided to the qualifying activity for correlation prior to shipment of parts. Measurements conditions shall be in accordance with 4.4.1.

4.3.3 Surge current. Surge current, see MIL-STD-750, method 4066. $I_{FSM}$ = 100 A; 6 surges; $t_p$ = 8.3 ms or rectangular pulse of equivalent $I_{rms}$; 3 surges. $I_O$ = 0 A; $V_{RMS}$ = 0 V; duty factor 1 percent minimum $T_A$ = +25°C.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. The following test conditions shall be used for $Z_{\theta JX}$, group A inspection: $Z_{\theta JX} \leq 2.5$°C/W.

$I_H$ = 5 A minimum.
$t_H \geq 100$ ms.
$I_M$ = 10 mA to 200 mA.
$t_{MD}$ = 200 µs maximum.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VIa (JANS) and table VIb (JANTX and JANTXV) of MIL-PRF-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table I, subgroup 2 herein.

4.4.2.1 Group B inspection, appendix E, table VIa (JANS) of MIL-PRF-19500.

| Subgroup | Method | Conditions |
|---|---|---|
| B3 | 4066 | $T_C$ = +100°C; $t_p \leq 8.3$ ms; $V_R$ = rated $V_R$(see 1.3); six 1/120 s surges; 1 surge/minute maximum. $I_F$ (surge) = 100 A dc; $I_O$ = 10 A dc. |
| B3 | 2037 | Test condition A, all internal wires for each device shall be pulled separately. |
| B4 | 1037 | 2,000 cycles, 25 percent rated $I_O \leq I_O$ applied $\leq$ rated $I_O$ (see 4.5.2) |
| B5 | 1027 | $I_F \geq 0.5$ A dc at $T_A$ = +25°C, for 96 hours, or adjusted as required by the chosen $T_A$ to give an average lot at $T_J$ = +275°C. |
| B6 | 3101 | See 4.4.1 except $t_H \geq 500$ ms. |

4.4.2.2 Group B inspection, appendix E, table VIb (JANTX and JANTXV of MIL-PRF-19500).

| Subgroup | Method | Conditions |
|---|---|---|
| B2 | 4066 | $T_C$ = +100°C; $t_p \leq 8.3$ ms; $V_R$ = rated $V_R$ (see 1.3); six 1/120 s surges; 1 surge/minute maximum. $I_F$ (surge) = 100 A dc; $I_O$ = 10 A dc. |
| B3 | 1037 | $I_F \geq 0.5$ A dc, $I_O$ (see 4.5.2); 2,000 cycles. |
| B4 | | Not applicable |
| B5 | | Not applicable |

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VII of MIL-PRF-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table I, subgroup 2 herein.

4.4.3.1 Group C inspection, appendix E, table VII of MIL-PRF-19500.

| Subgroup | Method | Conditions |
|---|---|---|
| C2 | 2036 | Test condition A, weight = 10 pounds, t = 15 seconds. |
| C2 | 1021 | Omit initial conditioning. |
| C6 | 1037 | $I_F \geq 0.5$ A dc, $I_O$ (see 4.5.2); 6,000 cycles. |

4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table IX of MIL-PRF-19500. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps and footnotes of table I, subgroup 2 herein, except $Z_{\theta JX}$ is not required.

4.4.4.1 Group E inspection, appendix E, table IX of MIL-PRF-19500.

| Subgroup | Method | Condition | Sampling plan |
|---|---|---|---|
| E1 | 1056 | 0°C to +100°C; 100 cycles. | 10 devices, c = 0 |
| E2 | 1038 | Condition A, t = 1,000 hours | 5 devices, c = 0 |
| E3 | | Not applicable | |
| E4 | 3101 | See 4.4.1, except $t_H$ = 500 ms | 10 devices, c = 0 |
| E5 | 1001 | Not applicable. | |

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in 4.3.2.1 of MIL-STD-750.

4.5.2 DC intermittent operation life. A cycle shall consist of an "on" period, when forward current is applied suddenly, not gradually, to the device for the time necessary to achieve an increase (delta) case temperature of +85°C +15°C, -5°C followed by an "off" period, when the current is suddenly removed for cooling, the case through a similar delta temperature. Auxiliary (forced) cooling is permitted during the "off" period only. Forward current and/or "on" time, within specific limits, and "off" time may be adjusted to achieve the delta case temperature. Heat sinks shall only be used if and to the degree necessary to maintain test samples with the desired delta temperature tolerance. The heating time shall be such that $30 \text{ s} \leq t_{heating} \leq 180$ s. The forward current may be steady-state dc, full-wave rectified dc, or the equivalent half-sine wave dc, of the specified value. The test duration shall be the specified number of cycles. Within the time interval of 50 cycles before and 500 cycles after the termination of the test, the sample units shall be removed from the specified test conditions and allowed to reach room ambient conditions. Specified end-point measurements for qualification and quality conformance inspections shall be completed within 96 hours after removal of sample units from the specified test conditions. Additional readings may be taken at the discretion of the manufacturer.

TABLE I. Group A inspection.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|---|---|---|---|---|---|
| | Method | Conditions | | Min | Max | |
| Subgroup 1 | | | | | | |
| Visual and mechanical examination | 2071 | | | | | |
| Subgroup 2 | | | | | | |
| Thermal impedance | 3101 | See 4.4.1 | $Z_{\theta JX}$ | | 2.5 | °C/W |
| Forward voltage | 4011 | $t_p \leq 400$ µs, duty cycle ≤ 2 percent pulse | | | | |
| | | $I_F$ = 6 A | $V_{F1}$ | | 1.0 | V dc |
| | | $I_F$ = 12 A | $V_{F2}$ | | 1.5 | V dc |
| Reverse current leakage | 4016 | DC method; $V_R$ = rated $V_R$ (see 1.3) | $I_{R1}$ | | 250 | nA dc |
| Breakdown voltage | 4021 | $I_R$ = 1.0 µA dc | $V_{(BR)1}$ | | | |
| 1N6664, 1N6664R | | | | | 100 | V dc |
| 1N6665, 1N6665R | | | | | 150 | V dc |
| 1N6666, 1N6666R | | | | | 200 | V dc |
| Subgroup 3 | | | | | | |
| High temperature operation: | | $T_A$ = +150°C | | | | |
| Reverse current leakage | 4016 | DC method; $V_R$ = rated $V_R$ (see 1.3) | $I_{R2}$ | | 75 | µA dc |
| Forward voltage | 4011 | \| $I_{FM}$ = 6 A, duty cycle ≤ 2 percent (pulsed); $t_p \leq 400$ µs | $V_{F3}$ | | 0.95 | V |
| Low temperature operation: | | $T_A$ = -55°C | | | | |
| Forward voltage | 4011 | $I_{FM}$ = 6 A, duty cycle ≤ 2 percent (pulsed); $t_p \leq 400$ µs | $V_{F4}$ | | 1.1 | V |
| Breakdown voltage | 4021 | $I_R$ = 1.0 µA dc | $V_{(BR)2}$ | | | |
| 1N6664, 1N6664R | | | | | 100 | V dc |
| 1N6665, 1N6665R | | | | | 150 | V dc |
| 1N6666, 1N6666R | | | | | 200 | V dc |

See footnote at end of table.

TABLE I. Group A inspection - Continued.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|---|---|---|---|---|---|---|
| | Method | Conditions | | Min | Max | |
| Subgroup 4 | | | | | | |
| Reverse recovery time | 4031 | $I_F$ = 0.5 A; $I_R$ = 1 A; $I_{(REC)}$ = 0.25 A; di/dt = 85 A/µs minimum. | $t_{rr}$ | | 35 | ns |
| Junction capacitance | 4001 | $V_R$ = 10 V; f = 1 MHz; $V_{SIG}$ = 50 mV (p-p) maximum | $C_J$ | | 100 | pF |
| Subgroup 5 | | | | | | |
| Not applicable | | | | | | |
| Subgroup 6 | | | | | | |
| Surge current | 4066 | | | 50 | | A |

1/ For sampling plan, see MIL-PRF-19500.

5. PACKAGING

5.1 Packaging. Packaging shall prevent mechanical damage of the devices during shipping and handling and shall not be detrimental to the device. When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

5.2 Marking. Unless otherwise specified (see 6.2), marking shall be in accordance with MIL-PRF-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. See MIL- PRF-19500.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No.19500 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, ATTN: DSCC-VQE, 3990 East Broad Street, Columbus, OH 43216-5000.

6.4 Substitution information. Devices covered by this specification are substitutable for the manufacturers' and users' Part or Identifying Number (PIN). This information in no way implies that manufacturers' PIN's are suitable as a substitute for the military PIN.

6.5 Interchangeability information. MIL-PRF-19500/594 is a T0-257 package version of MIL-PRF-19500/477, which is an axial leaded diode version.

6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Custodians:
Army - CR
Navy - EC
Air Force - 17
NASA - NA

Review activities:
Army - AR, MI, SM
Navy - AS, CG, MC
Air Force - 19, 85, 99

Preparing activity:
DLA - CC

(Project 5961-1981)

**STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL**

**INSTRUCTIONS**

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

| **I RECOMMEND A CHANGE:** | **1. DOCUMENT NUMBER**<br>MIL-PRF-19500/594A | **2. DOCUMENT DATE (YYMMDD)**<br>980703 |
|---|---|---|

**3. DOCUMENT TITLE**
SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, FAST RECOVERY, LOW LEAKAGE, TYPES 1N6664 THRU 1N6666, AND 1N6664R THROUGH 1N6666R JAN, JANTX, JANTXV, AND JANS

**4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)**

**5. REASON FOR RECOMMENDATION**

**6. SUBMITTER**

| a. NAME (Last, First, Middle initial) | b. ORGANIZATION | |
|---|---|---|
| c. ADDRESS (Include Zip Code) | d. TELEPHONE (Include Area Code)<br>Commercial<br>DSN<br>FAX<br>EMAIL | 7. DATE SUBMITTED<br>(YYMMDD) |

**8. PREPARING ACTIVITY**

| a. Point of contact: Alan Barone | b. TELEPHONE<br>Commercial 614-692-0510 DSN 850-0510 FAX 614-692-6939 EMAIL alan_barone@dscc.dla.mil |
|---|---|
| c. ADDRESS:<br>Defense Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad Street, Columbus, OH 43216-5000 | **IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:**<br>Defense Quality and Standardization Office<br>5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466<br>Telephone (703) 756-2340 DSN 289-2340 |